IN THE UNITED STATES PATENT OFFICE

--METHODS AND DEVICES FOR THE RELEVANCY TESTING OF AN
IDENTIFIER--

BACKGROUND OF THE INVENTION.

[0001]   The invention relates to a method for testing
the relevancy of an identifier which may be transmitted to
a communication means by way of network in a massage, a
test module therefor and furthermore a generating method
for the formation of a relevancy table provided for
relevancy testing of identifiers associated with an
identifier group and a generating module therefor.

THE PRIOR ART.

[0002]   In communication networks messages are
frequently not systematically sent from one source
communication means to one target communication but rather
transmitted in a so-called broadcast method to numerous
target communication means. The respective target
communication means must then on the basis of an
identifier, comprised in a respective message, for example
of a target address of the message or of an identifier for
a content of the message, decide whether the message is
relevant for it. Typical examples of this are bus systems
in which the bus system participants all receive messages
transmitted by the bus.

[0003]   If for a target communication means solely one
single identifier is relevant, relevancy testing of the
identifier still may be implemented using a simple
comparison operation comparatively easily. In the case of
a plurality of identifiers relevant for the target the
ascertainment of whether a respectively received
identifier is relevant for the communication means, is

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substantially more difficult. For instance, an identifier to be tested may be tested with reference to a list to be checked linearly of relevant identifiers.

[0004]   In the case of a somewhat improved method a halving technique is for instance employed for such a list. It is also conceivable that unlike irrelevant identifiers relevant ones are identified by an unambiguous, common feature, for instance a predetermined bit pattern, so that a simple comparison test would be possible, for example by masking the bit pattern.

[0005]   If a communication means, for instance a bus participant on a CAN bus (controller area network) bus receives messages having numerous different identifiers relevant respectively for the communication means, the above mentioned test methods will be cumbersome and slow. On the communication means side there must for this purpose be a substantial and expensive processor power.

SHORT SUMMARY OF THE INVENTION

[0006]   One object of the invention is to provide methods and devices rendering possible efficient relevancy testing of identifiers, which can be transmitted by way of a communication network in a message.

[0007]   In order to achieve these and/or other objects appearing from the present specification, claims and drawings, in the present invention a test method is provided for the relevancy testing of an identifier, which is able to be transmitted to a communication means by way of a communication network in a message, comprising the steps of:

[0008]   finding a first position in a relevancy table for the identifier on the basis of a calculating rule applied for the identifier,

[0009]   seeking at least one second position alternative to the first position for the identifier in

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the relevancy table on the basis of a move-on rule applied to the identifier in the case of conflict where the first position is not available, until an available position, not associated with some other identifier is found in the relevancy table,

[0010]   designation of the identifier as being relevant, if the identifier, or a value associated with it, is entered at the first or the at least one second position, and

[0011]   designation of the identifier as being irrelevant, if at the first position or the at least one second position a non-use marker is entered.

[0012]   In order to achieve the object appearing from the present specification, claims and drawings, in the present invention furthermore a testing module is provided for relevancy testing an identifier able to be transmitted in a message by a communication network, having test means for the performance of the above mentioned steps.

[0013]   The above mentioned test method and furthermore the test module essentially serve to render it possible for a communication means, which receives an identifier as part of message, to implement a rapid relevancy test on the respective identifier.

[0014]   In order to build the necessary relevancy table and accordingly to attain the object of the invention the following are furthermore provided: a generating method for building relevancy table (provided for a communication means) for relevancy testing of identifiers associated with an identifier group, said identifiers being provided for identifying messages relevant for the communication means and able to be transmitted by a communication network, in the case of which positions provided in the relevancy table and not associated with any identifier in the identifier group are marked with a non-use marker and

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in the case of which for each identifier of the identifier group the following positioning steps are performed:

[0015]   finding a first position in the relevancy table for the respective identifier using a calculating rule applied to the identifier,

[0016]   seeking at least one second position for the identifier in the relevancy table on the basis of a move-on rule applied to the identifier in the case of conflict, in the case of which the first position is not available, until an available position, not associated with any other identifier in the identifier group is found in the relevancy table,

[0017]   and entry of the identifier or of a value associated with it at the respectively found first or at least one second position,

[0018]   and a generating module for building a relevancy table (provided for a communication means) for relevancy testing of identifiers associated with an identifier group, and which are provided for identifying messages relevant for the communication means and able to be transmitted by way of a communication network, with marking means for marking positions provided in the relevancy table and not associated with an identifier of the identifier group and with positioning means for the performance of the above mentioned positioning steps for each identifier of the identifier group.

[0019]   Accordingly during generation of the relevancy table the same method steps are performed in principle as during testing an identifier on the basis of the relevancy table so generated and more particularly the same calculating rule and the same move-on rule are employed so that there is common inventive concept. The only difference is basically that for the generation of the relevancy table an identifier is entered at a specifically

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allotted position and relevancy testing serves to see whether an identifier to be tested is possibly entered at this position already.

[0020]   A significant basic concept of the invention is the application of the inherently known hash method to an optimized relevancy testing of identifiers with which messages relevant for the communication means are marked.

[0021]   Unlike the known methods the hash method is substantially quicker and more efficient. It is accordingly possible for extensive groups of identifier relevant for a communication means to be reliably tested in a relatively short time.

[0022]   For further optimizing the relevancy testing attention is called to the features recited in the claims and described in the specification.

[0023]   It is convenient to find a maximum number of working steps even during building the relevancy table for the identifiers of the identifier group relevant for the communication means and for example to hold such number ready for the communication means and/or the test module, such number being maximally necessary during application of the calculating rule and/or the move/on rule to the identifiers of the identifier group so that the maximum number may be employed as a discontinuance criterion during the relevancy testing of an identifier not contained in the identifier group.

[0024]   During relevancy testing it is then an advantage to have such a provision that the calculating rule and/or the move-on rule for the identifier to be tested is utilized for a predetermined maximum number of working steps and for the marker to be assumed to be irrelevant, if the respective position found after the predetermined maximum number of working steps in the relevancy table is allotted to a different identifier than the identifier to

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be tested.

[0025]   Owing to the optimized design of the relevancy
table the efficiency of relevancy testing may be
substantially increased and more especially it is possible
for the number of necessary working steps, that is to say
the application of the calculating rule and/or of the
move-on rule, to be reduced for instance in the case of
individual identifiers or on average in the case of all
identifiers of an identifier group.

[0026]   Therefore in the case of method there is a
provision such that for at least one identifier in the
identifier group a position in the relevancy table is so
associated in an optimized manner that the number of the
working steps necessary for finding the position is low in
the case of which more particularly the calculating rule
and/or move-on rule is applied.

[0027]   The at least one identifier positioned in the
relevancy table in an optimum manner is preferably
selected in accordance with a predetermined criterion and
more particularly in accordance with an expected rate of
transmission or in accordance with a priority of the
message respectively contained in it. It is possible as
well for a single identifier, as for example an identifier
which is particularly frequently contained in messages, to
be selected in accordance with a first criterion and for a
number of other identifiers, for instance particularly
significant identifiers to be dealt with applying a
priority, to be selected in accordance with a second
criterion.

[0028]   A convenient method of optimizing in the
generating method of the invention is such that the number
of the positions able to be associated with the
identifiers of the identifier group is increased or
reduced. Accordingly more especially the number, which is

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required on average for each identifier of the identifier group, of test steps may be reduced.

[0029] However, for optimizing the relevancy table an important aim is make it as small as possible for minimizing the memory capacity requirement in the communication means so that as many relevancy table positions as possible are associated with an identifier of an identifier group.

[0030] For this purpose the generating method is preferably so improved upon that the identifiers of the identifier group are transformed as part of the application of the calculating rule to a representation sub-set, on the basis of which positions in the relevancy table may be associated with the respective identifiers.

[0031] The representation sub-set is in this case preferably so generated that the positions associated with the respective identifiers are arranged evenly and avoiding conflict in the relevancy table. The calculating rule is accordingly so selected and/or modified that cluster formation, is prevented, in which several identifiers would compete with or conflict at the same position owing to an unmodified calculating rule. Owing to the modified calculating rule these identifiers are respectively given separate positions

[0032] For modification of the calculating rule several, single methods or methods able to be employed in any desired combination are suitable. For instance, a numerical value, which is more particularly determined as a random number is added to or subtracted from each identifier in the identifier group. Furthermore, each identifier could be multiplied with a multiplier or processed in logical operations, for example using logical "AND", logical "OR" or "shift".

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[0033]   It will be clear that after that a sort of "optimum" calculating rule found during the course of optimizing the relevancy table will be utilized by the test method and the test module as well.

[0034]   A further method of optimizing, which may be readily combined with the above mentioned ways of optimizing, is such that the order is varied, in accordance with which the identifiers of the identifier group respectively have positions in the relevancy table associated with them.

[0035]   It is in this manner that in certain cases it is not even necessary for the calculating rule to be modified in order to reduce the number of conflicts in the association of positions in the relevancy table with identifiers. Furthermore, it is possible for example for an identifier, which is to be frequently tested, or an identifier with a high priority, to be preferentially entered in the relevancy table.

[0036]   A particular advantage of the optimized relevancy table is to be seen in the fact that same may be produced "offline" using a generating module. For example, a high performance workstation or a computer network with a high processor capacity may be provided. Moreover, it is essentially irrelevant how much time is necessary for optimizing the relevancy table. Thus the above mentioned optimizing step may be readily tried out in different combinations by the generating module in order to generate a relevancy table with an optimum small size, in the case of which for relevancy testing of an identifier only a few working steps are necessary.

[0037]   The optimized relevancy table is made available for the test module, which for example is integrated in a receive component of a communication means. For instance, the relevancy table may be burned in a ROM. On the test

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module side and therefore on the communication means side only very little processor capacity is necessary, owing to the already optimized relevancy table, for the relevancy testing of an identifier.

[0038]   The following advantageous modifications of the invention relate both to the test method and the test module and also to the generating method and the generating module.

[0039]   As a marker of non-use it is possible for different marker types to be utilized. It is an advantage for a void marker to be provided as a non-use marker, such void marker being extremely readily detected by the test module. It is possible also for the non-use marker to be formed by an invalid value not associated with an identifier comprised in the identifier group, as for example associated with a value which is substantially larger than a value permitted for a valid identifier.

[0040]   In the case of application of the calculating rule and/or the move-on rule it is preferred for an indicator to be found pointing to the first and/or the respectively at least one second position in the relevancy table, this being performed by dividing the identifier or, respectively, a move-on value derived from same on the basis of division by a prime number, which corresponds to the number of positions provided in the relevancy table for identifiers. It is in this manner that the position to be associated with an identifier respectively in accordance with the calculating rule or, respectively, the move-on rule may be quickly found.

[0041]   In the case of a particularly preferred mode there is a provision such that the indicator is set as a whole number remainder of the division of the marker a value by a prime number. Instead of division by the prime number repeated subtraction of the prime number from the

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respective identifier may be provided for.

[0042]   Owing to the move-on rule two identifiers are associated with different positions, which owing to the calculating rule would otherwise be associated with or assigned to the same position in the relevancy table. In this case it is an advantage that the move-on rule essentially comprises the calculating rule. For this purpose for the application of the move-on rule for example firstly a move-on value is formed from an identifier, and such value is added to a current index at a position in the relevancy table. On the basis of this sum and using the calculating rule then a position for the identifier in the relevancy table is found. It will be clear that the same move-on rule must be employed in the generating method and in the test method.

[0043]   The identifier can in principle be any suitable value an indicator or the like in a message intended for the communication means,. It is convenient for the identifier to be contained in an address data item, more particularly in a target address, of a respective message or in a content identifier for a content of the respective message. In this case the identifier can constitute the target address or, respectively, the content identifier or only be a part of same. A fraction to be respectively tested and constituting an identifier of a target address or of a content identifier may for example be found by masking or shifting the respective target address or, respectively, of the content identifier.

[0044]   In principle it is possible for any suitable communication network to be provided, even one in which end-to-end communicate is provided. In the case of such a communication network as well a plurality of messages are possibly transmitted to communication means, which are to undergo relevancy testing and in which identifiers,

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suitable for this purpose, are provided. To take an example a message could be relevant in a predetermined operational state of the communication means but irrelevant in some other operational condition. However, there is a provision in the preferred form of the invention such that as a communication network a broadcast network is provided, in the case of which the communication means receiving the respective messages are compelled to perform relevancy testing of the messages, that is to say to perform filtering out of message which are respectively irrelevant for them.

[0045] Typical examples of broadcast networks are bus systems and more especially a Controller Area Network (CAN) bus system or a Local Interconnect Network (LIN) bus system as a communication network. CAN and LIN bus systems are more particularly utilized in automation technology or for motor vehicles. It is more particularly in the case of motor vehicles that the increasing number of electrical components, which must be controlled and monitored, means an increasing message traffic load on the respective bus systems. The bus participants then receive a large number of messages which are irrelevant for them, which can be rapidly removed using relevancy testing in accordance with the invention while only needling little computing capacity. As an example for a control component for a tail light messages relating to a car radio or a navigation system are unimportant.

[0046] Further advantageous developments and convenient forms of the invention will be understood from the following detailed descriptive disclosure of one embodiment thereof in conjunction with the accompanying drawings.

LIST OF THE SEVERAL VIEWS OF THE FIGURES.

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[0047]   Figure 1   diagrammatically shows a
bus 10 with communication means 11, 12 and 13, which
comprise test modules 14, 15 and 16, and furthermore
a developing tool 17 with a generating module 20.

[0048]   Figure 2   shows a message 19
transmitted on the bus 10.

[0049]   Figure 3   is a flow chart 23 of the
generating module 20 as in figure 1.

[0050]   Figure 4   is a flow chart for the
test modules 14, 15 and 16 in figure 1.

[0051]   Figures 5 to 8 show relevancy tables 22,
22b, 22c and 22d produced by the generating module
20 of figure 3.

DETAILED ACCOUNT OF WORKING EMBODIMENT OF THE
INVENTION.

[0052]   Figure 1 shows a bus 10 constituting a
communication network which is here a CAN bus or a LIN
bus, with its connected communication means 11, 12 and 13,
which constitute bus participants on the bus 10 and
represent examples of further communication means, not
illustrated.   The bus 10 is arranged in a motor vehicle 18
and includes bus lines 8 and 9, one bus line 8 and 9 being
for example constituted by ground common to the
communication means 11, 12 and 13.

[0053]   The communication means 11 is for example a
central control device for the control of local component
group controls, which for example are constituted by the
communication means 12 and 13 and for example serve for
the control of a tail light component group or distance
measuring means on the motor vehicle.

[0054]   The communication means 11, 12 and 13
communicate by way of the bus 10 with each other, each
message transmitted by way of the bus being received by
all communication means 11, 12 and 13 connected with the

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bus 10. When the communication means 11 for example
transmits a message, as for instance the message 19
illustrated in figure 2, to the communication means 12,
such message will also be received by the communication
means 13. While the message 19 is relevant for the
communication means 12, it is rejected by the
communication means 13 as being irrelevant.

[0055]   The message 19 comprises data and an identifier
ID, which for example is constituted by a target address
of the message 19 or an identifier for its content or is
comprised in the target address or, respectively, in the
content identifier of the message 19. The identifier I89
has a value (w) equal to 89 and constitutes a component of
an identifier group IDG, comprising further identifiers
I5, I1, I8 and I16 with values (w) of 5, 1, 8 and 16. The
identifiers I5, I1, I8, I89 and I16 mark message relevant
for the means 12, the identifier I89 marking for example
the message 19. The identifier group IDG in the present
case is structured as a single dimensional field or array.

[0056]   For the relevancy testing of identifiers the a
test module 15 is provided in the communication means 12,
which on the basis of a relevancy table 22; 22b; 22c and
22d tests identifiers comprised in a message and which in
the present case is a program module implemented by the
communication means 12. However, before the manner of
functioning of the test module 15 and of test modules 14
and 16 provided in the communication means 11 and 13 and
functioning like the test module is described in more
detail, the generation of the relevancy table 22; 22b; 22c
and 22d by a relevancy table will be described, which in
the present case is in the form of a program module
implemented by a development tool 17.

[0057]   The generating module 20 associates the
identifier I5, I1, I8, I89 and I16 with positions P0 to

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P10 in the relevancy table 22; 22b; 22c and 22d. In this
respect the generating module 20 applies the following
calculating rule

$$p = w \bmod d \tag{1}$$

[0058]   to the values 5, 1, 8, 89 and 16 of the
identifiers I5, I1, I89 and I16, p being an index on one
of the positions P0 through P10 of the relevancy table 22;
22b; 22c and 22d. The index P is formed as a whole number
remainder in a modulo operation with a divisor d on the
respective w value. In this case the divisor d is a prime
number and is equal to the number of positions P0 through
P10. In the present case d is equal to 11.

[0059]   It is convenient for the value of the divisor d
and accordingly the number of positions in a table to be
equal to about twice the number of the identifiers to be
associated with a given relevancy table. In principle the
divisor may however be found in a different manner. All
identifiers in an identifier group must be able to be
associated with one respective position in the respective
relevancy table.

[0060]   During the association of the identifiers I5,
I1, I8, I89 and I16 with the positions P0 through P10, the
generating module 20 performs the method 23 illustrated in
figure 3, in the case of which the relevancy table 22
depicted in figure 5 is produced. The method 23 is
performed for each of the identifiers I5, I1, I8, I89 and
I16 of the identifier group IDG.

[0061]   In a step, which is not illustrated, the
positions P0 through P10 are firstly provided with a non-
use marker, a void marker being provided in the present
case.

[0062]   In a step 24 the calculating rule (1) is applied

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to the respective w value of an identifier I5, I1, I8, I89 and I16. In this case for the identifiers I5, I1 and I8 the associations with or assignments to the positions P5, P1 and P8 are found. In a test step 25 an examination is in each case made to see whether the positions P5, P1 and P8 are not already associated with an identifier. This is in not so in any case, i. e. in the present case a void marker is entered, if the identifiers I5, I1 and I8 are to be associated with positions P5, P1 and P8 so that in one step 26 the generating module 20 can enter the values (w) of 5, 1 and 8 of the identifiers I5, I1 and I8 at the positions P5, P1 and P8.

[0063] During the application of the calculating rule (1) in the step 24 to the w value 89 of the identifier I89 however in the test step 25 it is found that the identifier I89 is to be associated with the position P1 already occupied by the identifier I1. Therefore following the test step 25 it is necessary to see that in a move-on step 27 an alternative position is found in the relevancy table 22 and to return in a return branch 28 to the test step 25 in order to check to see whether respectively found position is available. This does apply for the position P0 found for the identifier I89.

[0064] In the move-on step 27 the following calculating rules (2a) and (2b), which constitute a move-on rule (2), are applied:

$$inc = (w \bmod (d-1)) + 1 \qquad (2a)$$

$$p_{n+1} = (p_n + inc) \bmod d \qquad (2b)$$

[0065] In the calculating rule (2a), which may be performed in step 25, a move-on value inc is found from the respective value w of an identifier. The move-on

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value inc is added to the index pn at the position already occupied by an identifier. In the specific case the index $p_n = 1$ for the identifier I89 applies for the position P1 already occupied by the identifier I1 and in accordance with the calculating rule (2a) the move-on value inc = 10 applies. After application of the calculating rule (2b) to the sum

$$p_n + inc = 1 + 10 = 11$$

[0066]   the result is then the index pn + 1 = 0 pointing to the position P0. It will be seen that in the present case the calculating rules (1) and (2b) are essentially the same but with the difference that in accordance with the calculating rule (1) the modulo operation with the divisor d is applied directly to the value w of an identifier, whereas in accordance with the calculating rule (2b) the modulo operation with the divisor is performed on the sum of the move-on value inc and the index pn is applied on the currently found position already occupied by an identifier.

[0067]   For the identifier I16 the move-on rule (2) must be applied three times in all, since after the application of the calculating rule (1) the position P5 occupied by the identifier I5 and following this in the case of a triple application of the move-on rule (2) the positions P1, P8 (occupied by the identifiers I1 and I8) and only after this the position P4 are found. All in all for finding the position P4 four working steps ST are necessary, something which in figure 5 is noted in a column marked "ST". For the identifiers I5, I1 and I8 on the contrary only one working step ST is necessary, namely the application of the calculating rule (1). This is advantageous in the later described relevancy testing of the identifiers I5, I1 and I8.

[0068]   The relevancy table 22 produced in the method 23

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is illustrated in figure 5, and the individual method steps of the method 23 are indicated in columns marked as IDG, w, p, inc and ST and the lines marked I5, I1, I8 and I89. The relevancy testing table 22 and furthermore in principle the relevancy tables 22b, 22c and 22d depicted in figures 6 through 8 may for example also be defined as numerical series only, in the present case with the values 89, 1, 255,255, 16, 5, 255, 255, 8, 255 and 255 for instance, "255" meaning a non-use marker for a position in the sequence and masking an invalid identifier. It is also possible for further lines and/or columns to be provided in the relevancy table 22; 22b: 22c and 22d, in which data necessary for further processing of the respective message are present.

[0069]   In the following relevancy testing as represented in figure 4 for the identifier I89 will be explained on the basis of 22 using the test module 15.

[0070]   In one step 29 the calculating rule (1) is applied to the w value 89 of the identifier I89, the index of the position P1 being found. Furthermore a step counter 2 is initialized at for instance s = 1, which serves to limit the number of working steps in the relevancy table 22.

[0071]   In principle a maximum number smax could be set for the step counter by the number of the positions P0 through P10 in the relevancy table 22. In the present case however maximum number smax is defined as the maximum number of working steps given in the column ST; in the relevancy table 22 the value of smax is 4.

[0072]   In a test step 30 following the step 29 a test is made to see whether the value entered at the position P1 is the same as the w value 89 of the identifier I89. This is no so, since the position P1 is associated with the identifier I1 and accordingly the w value of 1 is

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entered there. After this in a test step 35 a test is
made to see if the position P1 has a non-use marker
entered in it, this being in the present case a void
marker. This is not the case either, since 1 as a w value
is entered at the position P1.

[0073] Therefore in a further step 31 the count s of
the step counter is firstly incremented by 1 and in a
following test step 32 a test is made to see whether the
step count s has already exceeded the maximum number of
smax. In the current run the step count s is at 2, that
is to say smaller than the maximum number smax of 4.

[0074] Accordingly following the test step 32 in a
move-on step 33 an alternative position is found for the
identifier I89 in the relevancy table 22. For this
purpose, as already explained with reference to the method
23, the calculating rules (2a) and (2b) of the move-on
rule (2) are applied to the index pn = 1 of the position
p1 and accordingly the position P0 is found. In the move-
on steps 23 and 27 the same operations are performed in
principle.

[0075] After the move-on step 33 in the test step 30 a
test is made to see whether the value entered at the
position P0 is the same as the w value 89 of the
identifier I89. Since this is now the case, in an output
step 34 an output is produced indicating that the
identifier I89 is an identifier relevant for the
communication means 12 and accordingly the message 19 is a
relevant message.

[0076] If the w value of the identifier I89 were not 89
but for example 2, the application of the calculating rule
(1) in the step 29 would result in an association with the
position 2. The result in the test step 30 would
admittedly be that the w value of 2 is not entered at P2,
but however then in the following test step 35 it would be

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found that a non-use marker is entered at the position P2.

Therefore in a following output step 36 an output would be produced to indicate that the identifier I89 with the w value of 2 is an identifier which is irrelevant for the communication means 12 and therefore the message 19 is an irrelevant message. The same result of "irrelevant", that is to say the output step 36, will be arrived in the test step 32, if after more than the maximum number of working steps (smax) of 4 neither a position with a non-use marker nor a position is found, at which the value of the respective identifier to be tested is entered. Without testing the maximum number (smax) of 4 working steps in the test step 32 in the relevancy table 22 in the worst case 5 working steps will be necessary for the relevancy testing of an identifier, since the identifier group IDG comprises 5 identifier in all, which are respectively associated with one of the positions P0 through P10 in the relevancy table 22.

[0077]   It will be clear that the test method may also be designed in some other embodiment, as for example with a different series, not illustrated, of steps. For instance the test steps 30, 32 and 35 could be performed in any desired order one after the other.

[0078]   The fact that not more than 4 working steps are needed involves an improvement in the relevancy testing in order to find the result of "irrelevant" in the case of an identifier to be tested. Furthermore there may be a case in which for example the identifiers I5, I1 and I8 are extremely frequently received by the communication means 12 so that the structure of the relevancy table 22, in which for the relevancy testing of the identifiers I5, I1 and I8 respectively only one working step is necessary, is well suited for the communication means 12.

[0079]   However, the relevancy table 22 may be so

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optimized that less working steps are required in order to come to the result of "relevant" or "irrelevant" in the case of an identifier to be tested, the test routine being terminated in the present case in the test step 32 when there is an irrelevant identifier.

[0080]   The generating module 20 optimizes the relevancy table 22 following criteria, which are preset by a user or for instance automatically. A preferred criterion is for example that the number of the working steps to be performed on average in relevancy testing is reduced. For the relevancy table 22 it is possible for example to stipulate that the maximum number (smax) of working steps is equal to 2.

[0081]   It has turned out to be advantageous firstly to enlarge the respective relevancy table so that conflicts between several identifiers at a relevancy table position are prevented and then to apply one or more of the following optimization routines. However, in order to present a clear picture in the present case there is to be no increase in the size of the relevancy table 22 here.

[0082]   In accordance with one optimization routine the identifiers I5, I1, I8, I89 and I16 of the identifier group IDG are entered in a different order in the relevancy table 22 and/or the associations of identifiers conflicting on association at one position are changed over. In this particular context in the relevancy table 22 the associations of the identifiers I5 and I16 with the positions P5 and P4 are problematical which are caused by the preferred putting in place of the identifier I5.

[0083]   Although initially, for such optimization, in the modified relevancy table 22b depicted in figure 6 the identifier I5 is associated with the position P5, then however the identifier I16 has been associated with the position P5 and for the identifier I5 the substitute

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position P6 has been found for the identifier I5 by the application of the routine 23. It is also possible for the order of the identifiers I5 and I16 in the identifier group IDG to be changed over prior to the association with the positions P0 to P10 in the relevancy table 22b.

[0084]   In the column ST it will be seen that the maximum number (smax) is 3, i. e. 3 working steps are required in relevancy testing.

[0085]   A further optimization routine or method is employed in the relevancy table 22c illustrated in figure 7. Here the w values 5, 1, 8, 89 and 16 of the identifiers I5, I1, I89, I16 are shown on transformed values (wt) of 9, 5, 12, 93 and 20. The transformation formula (3) for this is (in the case of the example of figure 7):

$$wt = w + z \qquad\qquad (3)$$

[0086]   In the present case a numerical value (z) of 4 is entered. In building the relevancy table 22c then instead of the w values the transformed wt values given in a column denoted wt are employed in the calculating rule (1) and the calculating rule (2a) of the move-on rule (2). As 22b in figure 6 there is a maximum number (smax) of 3.

[0087]   For the numerical value z in a optimizing routine it is advantageous to try out all values lying between 0 and d-1 and the maximum number smax is respectively found. Thus an optimum number value z can be found. It is also possible to utilize some other transformation formula. For instance, the w value could be multiplied by z: f. i. $wt = w * z$. Furthermore a combination of addition and multiplication could be performed, f. i. $wt = (w + z) * m$, "m" being a selectable and optimizable multiplier. The generating module 20 can

in any case try out various different transformation
formulas so that an even distribution of the identifiers
I5, I1, I8, I89 and I16 is brought about on the relevancy
table 22.

[0088]   A combination of the optimizing method
illustrated in figures 6 and 7 is applied in the relevancy
table 22d illustrated in figure 8. Here on the one hand
the transformation formula (3) with a numerical value (z)
of 4 is applied to the identifier values I5, I1, I8, I89
and I16 and on the other hand the association of the
identifier I89 is changed, for whose placement in the
relevancy table 22c three further working steps were
necessary. The identifier I89 is here preferably placed
in front of the identifier I1 so that the identifiers I89
and I1 are associated with (i. e. assigned to) the
positions P5 and, respectively, P0. The maximum number
(smax) will be 2 in the relevancy table 22d as originally
aimed at.

[0089]   It will be clear that the above mentioned
optimizing methods may be in principle be employed in any
desired order and combination by the generating module 20
so that ultimately an optimum relevancy table for an
identifier group is built. The respectively produced
relevancy table and the formulas used, the calculating
rules (1), the move-on rule (2) and any transformation
formula (3) employed therefor are then made available for
the respective test module.

[0090]   It is also possible for a program code of a test
module, for example of the test module 15, to already
contain the calculating rule (1) the move-on rule (2) and
any transformation formula (3) and/or the respective
relevancy table in figure 1 for example the relevancy
table 22d. It is an advantage for the generating module
20 to be designed to produce the respective test module or

to have ready a producing module, not illustrated, implemented for example by the development tool 17, and/or programming tool, which for example comprises a compiler and a linker, as is marked in figure 1 in chained lines at the test module 15 on the development table 17. The test module so produced, for example the test module 15, and/or the respective relevancy table, for example the relevancy table 22d, is then made available by the development tool 17 for the respective communication means: in the working example for example the test module 15 is loaded by way of a connection 37 into the communication means 12.

[0091]   It is also possible for the test module 15 to be employed by the development tool 17 to check over a relevancy table (for example the relevancy table 22d) generated by the generating module 20.

[0092]   The development tool 17, which is more particularly a personal computer or a workstation, and the communication means 11, 12 and 13 are only diagrammatically illustrated in figure 1. The respective functional component groups of such means are of the same type from the functional point of view, while being different in their specific structure and more particularly in their performance.

[0093]   The development tool 17 and the communication means 11, 12 and 13 respectively possess control means 40, memory means 41 and transmission and receiving means 42 connected together by means which are not illustrated. The control means 40 are for example separate processors or processor groups, with which a program coder may be implemented by program modules, which are stored in the memory means 41. The control means 40 of the communication means 11, 12 and 13 implement for example the program code of the test modules 14, 15 and 16 and the control means 40 of the development tool 17 implement the

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program coder of the generating module 20. In the case of the memory means 41 it is for example a question of hard disks and/or random access memory (RAM) components serving as working memories. In the case of the communication means 11, 12 and 13 the control means 40 are for example constituted by microprocessors.

[0094] Further components provided as part of the development tool 17, as for example display means (picture screen or LCD) and input means (keyboard and/or mouse) are omitted to make drawing more straightforward. The communication means 11, 12 and 13 may for instance be a component of a motor vehicle 18, for example a tail lighting unit.

[0095] Variations are readily possible in the invention.

[0096] To take an example instead of the calculating rule (1) some other calculating rule rendering possible an association of the identifiers I5, I1, I8, I89 and I16 with the relevancy table 22; 22b; 22c and 22d could be provided. Furthermore, the move-on rule (2) could be modified or replaced by an alternative move-on rule.

[0097] The test modules 14, 15 and 16 could be implemented in the form of hardware, for example ICs of the transmission and receiving means 42.

[0098] The respective relevancy tables could constitute a component of the test modules 14, 15 and 16 or respectively be read in by same. For instance, a relevancy table could be loaded in a ROM, which is configured by the development tool 17 for the test module 15.

[0099] It is also possible for the generating module 20 to be implemented by the control means 40. For instance, when a message relevant for one of the communication means 11, 12 and 13 is defined and thus a further identifier is

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relevant for the respective communication means, the
generating module 20 could arrange or enter the respective
identifier in a relevancy table present in the
communication means or in the respective test module, and
possibly also perform the above mentioned optimizing of
the respective relevancy table 22.